NEOCENE DEPOSITS OF THE KLAMATH REGION, CALIFORNIA.

Description.— In the Klamath region west of the Sacramento River, chiefly in Trinity county, there are several deposits of alluvial gravel and sand which seem to correspond to the auriferous gravels or "high-level channels" of the Sierra Nevada region. They were first mapped in 1892 by Diller[1] as Neocene deposits, and correlated with the Ione formation. Four separate areas are known within Trinity county, one in the old valley of Trinity River between Trinity Center and Junction City, another in Hay Fork valley, the third in Indian Creek valley, and the remaining one in Hyampour valley. Doubtful remnants may occur near Lowden's ranch and Big Bar on Trinity River.

These deposits occur in valleys of erosion, trenched deeply into the hard metamorphic rocks. The distinguishing characteristics of the old or Neocene valleys are (1) their great width compared with the Pleistocene valleys; (2) their flat bottoms; (3) their abrupt termination at both ends; and (4) their usually containing remnants of Neocene channel deposits. The writer is familiar with three of these valleys and will describe them in some detail.

Scott valley, in Siskiyou county, has a length of about twenty miles and an average width between three and four miles. Its direction is north-south and it lies between parallel ranges of mountains of which that on the west consists of very resistant formations, including micaceous quartz, schist, serpentine, and granodiorite, and attains a general elevation above the valley of four thousand feet. The range on the east is not nearly so high, owing to the formations composing it being the rather soft slates of the Devonian and perhaps Carboniferous. The valley itself is trenched largely into these slates, but reaches serpentine and the older schists beneath them. Undoubtedly the unusually great

[1] *Fourteenth Annual Report of the U. S. Geol. Surv.*, Pl. XLV.

width of this valley is due to the rather soft nature of the formations, but the fact remains that all other valleys of this region carved into the same formations are relatively narrow and have the gulch form, which, in the Klamath region, is the characteristic of the Pleistocene valleys.

Scott valley terminates as abruptly at the northern or downstream end as at the other, and Scott River drains it through a narrow gorge which is only partly explained by the hardness of the formations cut into. This valley has no known Neocene remnants, as its floor is so elevated (about three thousand feet above the sea) that subsequent erosion may have completely removed them. Its identification as Neocene rests on its large size and its abrupt termination at both ends.

The Hay Fork valley, in southern Trinity county, has a length of about eleven miles and an average width between one and two miles. Its course is a little south of west, or obliquely across the strike of the formations, which here occur in parallel belts as they have been folded and faulted. The strata of the metamorphic rocks stand at a high angle, usually approximating to the vertical. The flat floor of the valley has an altitude at Hay Fork village of about 2,200 feet above tide and the surrounding mountains rise to an average height of about 4,000 or 4,500 feet above the sea. The valley is, therefore, quite a deep trench and a prominent feature of the topography. Its walls are comparatively steep. The form of the valley shows distinctly that it is the result of ordinary stream erosion. There would be nothing remarkable about this valley if it were not that it is the only one of the kind in that portion of the country. All the neighboring valleys are relatively narrow and of the gulch type. Hay Fork stream enters the valley on the south about four miles from its eastern end, coming out of a narrow, gorge-like valley. Above this point the Hay Fork valley is occupied by an insignificant stream which seems out of place in the large valley. As there is nothing in the structure to explain the great contrast in size and shape of the valleys, we naturally conclude that the broad Hay Fork valley belongs to a separate and older system.

To what extent this valley may have been filled up by alluvial action we do not know, as, since its elevation, erosion has nearly reopened it, and the Neocene deposit within it appears merely as a small remnant. It seems to be continuous from end to end, and back of Hay Fork village forms a sort of terrace, occupying the north half of the valley and rising about sixty feet above the present stream level. It consists chiefly of layers of fine gravel and sand, indicating ordinary alluvial action. Near the upper end of the valley, interstratified with the gravel, I have found at least one bed of a white chalky material which seems to be rhyolite tuff, and Anderson reports this material from other parts of the formation. Near the lower end of the valley, where the deposit of gravel occurs in the bed of Hay Fork Creek, the stream exposes layers of lignite. It is the presence of this impure coal and the supposed tuff which postulate a pre-Pleistocene age for the deposit and the valley in which it occurs.

Hay Fork valley is terminated at the western or downstream end by a sudden narrowing of the valley of the Hay Fork Creek, which drains the old valley through a deep rocky gorge (said to be a veritable cañon), not to be explained by an increase in that direction in the resistant properties of the metamorphic formations.

Before discussing the Neocene deposit of the Trinity River, which is in many respects the most interesting and instructive of these old river channels, it will be necessary to direct attention to one of the most salient points in the later history of this region. This is the abandonment by the Trinity River of its original course, between Trinity Center and Junction City, and the excavation by it of a new valley roughly parallel to the old, and distant from it on the average about five miles. The new course is southeast of the old, on the outer side of a curve and consequently considerably longer than the original course. The two valleys are separated by a rock ridge of no mean height. The new valley is comparatively narrow and of the gulch type, although its floor in places has a width of one-fourth to one-half mile.

Now, on the direct line between Trinity Center and Weaverville, and thence to Junction City, there is a distinct basin or broad valley, three or four miles in average width, and partly floored by another of the Neocene River deposits. The general altitude of this basin is toward the north, about 3,500 feet above the sea, or 1,300 feet above neighboring portions of the present Trinity River. Examined in detail, the present floor of the basin is found to be quite uneven. Since the abandonment of this course by the Trinity River, streams which issue from the high mountains on the west, and formerly joined the main river in the basin, now continue across it and transect the rock ridge beyond, and have cut cañons or narrow valleys in the floor of the basin. A large part of the surface has been reduced much below the original level. So far as the channel deposit is concerned, only two limited portions of it are regarded as preserving essentially the original surface.

On the west of the basin rise abruptly to altitudes of seven and eight thousand feet, the bare rugged peaks of the Sierra Costa Mountains. The Trinity range on the east is much lower, and it is difficult to fix the original line between the basin and these mountains.

The old channel deposit is continuous from a point about one mile south of Swift Creek to the La Grange hydraulic mine on Oregon Mountain, between Weaverville and Junction City, a distance of twenty miles. It lies along the western edge of the basin, at the foot of the high mountains. Northward from Weaverville, it is known through its exposure on the sides of the deep transverse valleys, to occupy a deep valley about one mile in average width, and having remarkably steep walls, a veritable cañon. This cañon seems to be an old valley of erosion, which was completely filled with alluvial gravel and sand, giving the Neocene deposit a great thickness, which is one of its remarkable features.

We have no data for determining the actual thickness of the deposit, but we can fix upon a mininum in the latitude of Buckeye Mountain, a few miles northeast of Weaverville. Buckeye

Mountain is a ridge of gravel transverse to the course of the channel. Close by on the north, Stewart's Fork River has cut a valley across the old channel to the depth of 1,600 feet, without reaching the bottom of the gravel. On the southwest, a well in Weaverville is said to have penetrated over 600 feet of gravel and sand before reaching the metamorphic rocks. At least 1,000 feet in thickness of the deposit was removed in the erosion of Weaver basin. A thickness of the old channel deposit of 1,600 feet is a very conservative estimate. On Oregon Mountain the La Grange mine exposes 500 feet in depth of these gravels. North from Stewart's Fork several streams, Stope Creek and the East Fork of Stewart's Fork, have cut transverse valleys through the old channel to a depth exceeding 500 feet, and have not reached its bottom. That its thickness is abnormally great for an alluvial deposit needs no further evidence.

Lithologically, the formation is just an ordinary river gravel, irregularly stratified in the manner common to such deposits. The pebbles, cobbles, and small bowlders are very plentiful, and have been derived from the metamorphic rocks of the neighborhood. The predominating species in any section is that of the bordering terrane. Below the zone of oxidation the color is a deep blue, but higher, yellow and buff predominate, and at the surface there is a deep staining of bright red. There is much clay among the gravel, in places gathered into separate layers.

At the mouths of certain valleys which issue from the high mountains on the west, as, for instance, Stope Creek and the East Fork of Stewart's Fork, northwest of Minersville, after the completion of the main deposit, it was covered by alluvial fans remarkable for the immense bowlders, largely of granodiorite, which are thickly packed in them. So old are these deposits that all the bowlders are decayed, and a ditch or a fresh natural section, as a recent landslide, shows merely their outlines, and never a projecting rock — that is, the bank is smooth, like a clay or sand bank. On the main channel deposit near its original surface, there are no bowlders or cobbles scattered about, all

having disappeared by decay, but deep in the formation the cobbles are comparatively fresh.

The age of this deposit is considered to be the same as that of the Hay Fork, Indian Creek and Hyampour, because it is of similar lithologic character, occupies a similar valley, and has suffered great erosion since its abandonment by Trinity River. No coal is known from this area, and no tuffs have with certainty been discovered in it. No bones or fossil plants have yet been reported from it. However, it has not been closely examined for them, and even the tuff may occur and have escaped notice.

Conditions of accumulation. — Several interesting problems are presented by the old Trinity River deposit. What were the conditions which caused the accumulation of 1,600 feet of alluvial gravel and sand? Why did the river abandon its old course and cut a new valley on a longer course?

Let us first inquire into what fixed the site of the old valley. The abrupt southeastern face of the Sierra Costa Mountains on the west side of the old Trinity valley has the appearance of a degraded fault scarp. After long consideration of the matter, I have concluded that while there may be an old fault on this line, it has had very little influence on the present topography. It is along this line that the resistant serpentine and granodiorite of the higher mountains meet the rather soft and easily eroded Bragdon slate and the Clear Creek volcanic series, the Mesozoic representatives in this region. The mountains on the west are high because the rocks are very resistant, and those on the east are low because the rocks are softer. Along the junction between the two areas was a line of unusual weakness, perhaps because of an old fault, and that controlled the Trinity River between Trinity Center and Weaverville. In the course of time the river varied somewhat from the fault(?) line, and at one place cut its deep cañon entirely on the serpentine side of the line. This strengthens its interpretation as a valley of erosion.

The accumulation of 1,600 feet of gravel and sand by river action could have occurred under one of only two conditions; either a depression of the land to a lower level relatively to sea

level, or the local sinking of an orographic block bounded by faults, such as Professor Whitney adduced in explanation of Yosemite Valley. Dr. A. C. Lawson has called to my attention that in Europe, particularly in Germany, there are depressed areas of no great width which clearly have resulted from a "dropping out of the bottom," as we may say. The flat bottoms, steep walls, and canoe shape of the valleys occupied by the Neocene deposits in Trinity county seem to favor this theory, but against its adoption I have the following objections :

1. Outside of the four or five Neocene valleys already mentioned, there is no evidence in Trinity county of Neocene or later faulting. We know there have been gentle disturbances, broad arching of the strata, but no general breaking up of the rocks. The faulting would have to be strictly localized or confined to these valleys. Where the faults intersected at the corners of these valleys they must have terminated abruptly, not gradually dying out as is the habit of faults.

2. The valleys trend in different directions, so that there could be no regularity in the system of dropped fault-blocks, as there usually is.

3. The old Trinity valley is rather too crooked, and the crooks are not systematic enough to fit into such a scheme of dropped fault blocks.

4. The coarse character of the deposit throughout the Trinity area shows that the valley was kept filled up to a river level during a progressive sinking, and had there been a sinking of the rock floor relative to the walls, the gravel deposit should in its lower portions be much disturbed and bent up along the borders, a structure which has not yet appeared in the deepest natural or artificial excavations.

5. But the strongest objection of all lies in the fact, which may be particularly observed in the case of the old Trinity valley, that these valleys do show the influence on their width of the varying resistant properties of the formations traversed. The northern portion of the old Trinity valley is narrow (averaging one mile) because it is trenched into serpentine and the

Clear Creek volcanic series, both relatively resistant. In the Weaver basin it entered an area of the Abrams mica schist, which observation elsewhere has shown to be one of the less resistant formations, and here the valley widened out to three and four miles. When it entered the much harder hornblende schist west of Weaverville, it contracted very rapidly to less than one mile. I do not see how we can get around this evidence that this is a simple valley of erosion, and not a depression resulting from the sinking of a fault block.

The other hypothesis has an objection also. It is another unusual feature of these Neocene valleys that they had few tributaries. Probably the small streams came down from the uplands in short cañons with steep gradients. Pleistocene erosion, in developing the gulches, has largely obscured these earlier ravines. Outside of the Sierra Costa range it was a region not unlike that of the Sierra Nevada today, with the smaller streams flowing in shallow valleys on the uplands, and only the trunk streams in deep cañons. The topography seems to have been young, so far as that particular cycle of erosion was concerned. Naturally we would suppose that all the streams were flowing far above a baselevel of erosion, but in the flat bottoms of the old valleys and their width of nowhere much less than a mile and in places as much as four miles, we seem to have evidence that the trunk streams at least were approaching a baselevel of erosion. I will acknowledge that there is something apparently contradictory and unnatural about this, and I am unable to give a satisfactory explanation of it. However, if the Neocene valleys are the product of erosion, the fact remains that some deep cañons were excavated beneath the general level of the country. The evidence seems to me to indicate a sharp uplift of most if not all of the Klamath region in the Neocene, preceding the accumulation of the old channel deposits. The elevation may have had a maximum of several thousand feet in Trinity county and probably died out to zero on the borders of the Klamath province.

Following this elevation there seems to have been a slow

subsidence of the same area, to enable the old channel deposits to accumulate to such great thickness in the wide cañons of the trunk streams. It is only in the Trinity valley deposit that a great thickness is seen, but there are no reasons for believing that similar accumulations were not made in the other valleys. The preservation of the deposit in Trinity valley has been especially favored because the main stream abandoned the valley, which was not the case in the other valleys. It is probable that all the Neocene valleys were filled with alluvial deposits up to a certain baselevel plane and since largely reopened by erosion, a history which Lawson has shown to be duplicated in the Salinas valley in the southern Coast Ranges.[1]

If we will take our stand on the summit of the low mountain range just west of the Trinity river at Bragdon, we will get a fair idea of the condition of the surface at the close of deposition of the old channel deposit. We overlook the Neocene basin for miles to the northward and southward. We see that two limited areas apparently represent the original surface of the alluvial deposit. Some miles to the southward the summit of Buckeye Mountain appears, where it is composed of the river gravel, as a ridge with perfectly even crest-line, but sloping toward the east-southeast at a regular and low angle, estimated at about one hundred feet per mile. The altitude is 3,800 feet.

A little north of west from us, and distant only a few miles, another apparent remnant of the original surface forms a sort of plateau, only very slightly trenched by erosion, and known as the Greenhorn Flats. The elevation is about the same as Buckeye Mountain, and there is a distinct slope toward the east-southeast at a regular rate of about the same degree as the other remnant. The conviction is forced on the observer that the entire deposit north of Weaverville has been tilted toward the east-southeast at the rate of about one hundred feet per mile, and the suspicion is raised that this tilting was so rapid that the Trinity River could not maintain its old course by down-cutting

[1] *Bulletin of the Department of Geology, University of California*, Vol. I, p. 154.

into the gravel, but was forced on to the metamorphic rocks to the eastward, and so came to trench its new valley.

If we will project the reconstructed surface of the gravel deposit toward the east, we will find that it about intersects the general summit level of the ridge of metamorphic rocks between the old and the new courses of Trinity River. Beyond the new valley we will find no elevation prominently reaching above this plane until we get well up toward the summit of Trinity Mountain. As there is no evidence of faulting since the accumulation of the Neocene gravels, it is evident that at the completion of the river deposit, when its surface had reached that now represented by Buckeye Mountain and the Greenhorn Flats, the alluvial plain was bordered on the east by a low, flat belt of country, five and perhaps in places ten miles wide, a local baselevel of erosion. It is not certain that this was a perfect flat all over; indeed, it is probable that it was a series of broad valleys in which flowed the tributary streams, separated by low, smooth, in places indistinct, divides.

Certainly, the country for some miles east of the old channel was low enough to enable Trinity River to rapidly migrate across it until it had reached a distance of three to seven miles from the old course, when the vertical component of the uplift became the controlling factor, and the river simply stopped migrating and cut down into the underlying metamorphic rocks.

It is presumed that the uplift of the Klamath region was general throughout the province, but the amplitude varied. The country was bowed up into one or more great arches without faulting, except possibly on the northeastern and southwestern borders of the mountain system. From the group of high mountains west of the old Trinity valley to the present Sacramento valley near Redding, I regard as the eastward slope of one of these great arches. Between Redding and Shasta there are traces of an old peneplain[1] earlier in age than that on which the Red Bluff gravels lie, and this I would correlate with the late Neocene baselevel developed on the east border of

[1] JOUR. GEOL., Vol. II, pp. 34, 35.

Trinity valley. The former rises from six hundred to about one thousand feet above the sea in less than three miles. Projecting this plain westward and the tilted baselevel of Trinity valley eastward until they intersect, we would find that nearly all of the gulches lie below this level, while the mountain tops which reach above it have a more subdued and older-appearing topography.

Completed baseleveling was only effected on narrow strips on the border of the Sacramento valley and on the east border of the Trinity valley. The country between was quite undulating, and contained rounded mountains reaching elevations of 1,000 and even 2,000 feet above the neighboring baselevel. These residuals were of the same category as those in the McCloud-Pit projection of the Klamath mountains, which may be shown to rise as monadnocks above an uplifted baselevel, represented by Bagley Flat.

At the Big Bend of Pit River and along Kosk Creek, a northern tributary, the Ione sandstone, as identified by Diller[1] is strongly developed, having a probable thickness of about six hundred feet. It dips easterly at a low angle, and passes under the lavas of the Lassen volcanic range. On the west, the surface of the metamorphic rocks of the Klamath region, here chiefly Jurassic in age, come out from under it and rise to the westward at about the same angle as the eastward dip of the sandstone. The Ione pebbles are scattered over this slope to a distance of several miles from the present Ione escarpment. This slope represents the pre-Ione surface of the Klamath region, and consequently is not the equivalent of the latest stage of the Sierra Nevada peneplain.

On the north side of Pit River, west of Cañon Creek, there is a high terrace known as Bagley Flat. It is a shelf cut into the slope of the Klamath mountains. Its present altitude is about 2,750 feet, or 1,200 feet above Pit River. It corresponds in height with the lava plain on the south of the river, but instead of being a constructional plain of sandstone overlaid by andesite, it is a baselevel of erosion. The Neocene lava occurs as rem-

[1] Lassen Peak Folio of the *Geologic Atlas of the United States.*

nants on this shelf, fixing its age as that of the andesite eruption. I regard it as a sort of coastal plain of erosion, baseleveled by the body of water in which the Ione sandstone was deposited. After the Ione formation was completed, the andesitic lava flowed over the sandstone area and lapped over on to this narrow coastal plain. This andesite, from its lithologic character and from its relations to the underlying Ione formation and an overlying basalt, may be correlated with the andesitic tuffs and lavas partly burying the Sierra Nevada peneplain. Hence, Bagley Flat is the equivalent of the Middle Pliocene peneplain of the Sierra Nevada region.

Back of Bagley Flat, two mountains, Bagley Mountain and another unnamed, rise rather steeply to altitudes respectively of 4,437 and 3,905 feet, and were monadnocked on the baselevel of the Middle Pliocene to the extent approximately of 1,600 and 1,100 feet. West from here, as far as the Sacramento River, the Klamath mountains consist of a group of peaks, of which these two mountains are members. While the general surface slopes to the south and the peaks reach altitudes of 4,000 to over 6,000 feet, there is not sufficient uniformity in their height to suggest a dissected peneplain. These peaks have the aspect rather of monadnocks, and the relation of several of them to Bagley Flat shows that they belong to the same category as the monadnocks of the Sierra Nevada region. This portion of the Klamath region was nearly all residual, baseleveling only being effected on a narrow strip around the head of the Sacramento valley. It is a significant fact that the Klamath mountains rise much more abruptly on the side of the great valley than do the Sierra Nevada Mountains. This is beautifully exemplified by a view toward the north from Redding, where Bear Mountain and other peaks in the vicinity appear to rise sharply from the plain.

A view toward the southeast from Brock Mountain shows a number of flat-topped ridges bearing a marked resemblance to eastern dissected peneplains, but this is quite local, and I do not know its significance. If any older peneplain than the Middle

Pliocene of the Sierra Nevada region was developed in this region, it has been completely destroyed by erosion, and is not identifiable, while, as already intimated, the Middle Pliocene baselevel did not penetrate far from the border of the present Sacramento valley. In general, we may say, the present topographic features are older than those which dominate the Sierra Nevada country.

The nearest approach to the development of a late Neocene peneplain in Trinity county was effected at the close of deposition of the Neocene gravels. The surface of the alluvial deposits rose by aggradation and the neighboring rock surface sank by degradation, until at the close of the epoch the two planes met. This is precisely the same relation that exists between the auriferous gravels and the peneplain of the Sierra Nevada region, indicating that we are treating equivalent and contemporaneous events. So confident am I that this is true that I am inclined strongly to accept the Neocene baselevel of the region under discussion as a datum plane of the same value as the Sierra Nevada peneplain, consider its maximum development of rather late Pliocene age, and base upon it speculations as to the ages of all other physiographic features in the province.

The Sierra Costa Mountains rose above the Neocene baselevel to elevations of three to five thousand feet, and had a topography similar in its larger features to that of today. The higher valleys of these mountains are essentially the valleys of the Neocene. They are commonly called "cañons" by the miners, because they have relatively broad floors and very steep walls. Part of this cañon-like form is due to glaciation, but more is preglacial in its origin. The work of the glaciers was short and confined to a removal of talus from the foot of the precipices, to the smoothing of inequalities, and to the filling of the deeper portions of the valleys by drift débris.[1] Beyond the ends of the glacier sites, the same broad valleys continue at the same level, but this fact is obscured by the Pleistocene erosion of deep gulches in the bottoms of the older valleys, the slopes of which

[1] JOUR. GEOL., Vol. VII, 1899.

later system of valleys often coalesce with the slopes of the older valleys so as to make the whole trench, perhaps five thousand feet in depth, appear as the work of a single cycle of erosion. Usually, however, there is a shoulder high up on the slopes which is not always explained by the structure or by landslides, and the concurrence of a series of these shoulders at about the same elevation on both sides of one of these valleys raises the suspicion that they represent the bottom of the Neocene valley.

So far as is now known the Sierra Costa range is the only portion of the Klamath region or indeed of any part of northern California which possessed a rugged, sierra-like topography during the late Neocene, and it should be awarded the distinction of being the oldest prominent mountain range within the state, unless such exist south of the Tehachapai range.

Correlation.—Rhyolite tuff has been found by Diller in the Indian Creek basin, and I believe also in Hyampour valley, and by Anderson and the writer in Hay Fork valley. The first investigator thought the material had been showered over the hills as fine ashes and then carried down into the streams, and thus became interstratified with the alluvial gravels. It was largely because of the presence of this tuff that he provisionally correlated the Neocene gravels in Trinity county with the Ione formation. At the same time he recognized the possibility that the tuff may have been derived from the group of volcanoes in the Coast Range region, in Lake county, and may not belong to the epoch of rhyolitic extrusions in the Sierra Nevada region.

The latter represent a distinct epoch of the period of vulcanism, and this rhyolite epoch was contemporaneous with the accumulation of the auriferous gravels proper or high-level channels. The latter are now thought to be the chronologic equivalent of the San Pablo formation, presumably of Lower Pliocene age. If the rhyolite tuff of the Klamath region was derived from the Sierra Nevada or Lassen Peak volcanoes, it would imply that the tuff-bearing portion of the Neocene gravels is probably Lower Pliocene in age. The presence of lignite in

the Hay Fork and Hyampour valleys also favors this correlation, for lignite is very characteristic of the Ione formation, another supposed equivalent of the San Pablo formation.

However, it seems to the present writer more probable that the rhyolite tuff was derived from the Lake county volcanoes. There is a great mass of tuff in the upper end of the great valley, extending west of the Sacramento River, and clearly referable to the Lassen Peak volcanic range as a source, but it is andesitic in character. None of this reached the Trinity county basins so far as I am aware. The occurrence of the rhyolite tuff in the southern part of Trinity county alone seems to imply that it was showered from the south and not from the east. Strong winds come oftener from the direction of Lake county than from that of the Lassen Peak range.

I am informed that the volcanic series of Lake county is essentially Middle Pliocene in age, being apparently the equivalent of the Berkeleyan series. About the close of deposition of the San Pablo sandstone, rhyolitic ashes seem to have been widely showered over the northern Coast Range region, and it is probable that at this time similar material reached the Trinity county basins.

Whether we refer the source of the tuff to the Sierra Nevada Lassen Peak or to the Lake county volcanoes, we arrive at virtually the same result in the matter of the probable age of the tuff-bearing portion of the Neocene gravels of the Klamath region, namely, about the time of transition from the Lower to the Middle Pliocene.

The lignite and tuff are found near the rock-floor of the old Neocene valleys, and simply tentatively fix the age of the lower portion of the gravel series. The accumulation of the gravel continued until the inception of the profound orographic disturbance to which the Pleistocene valleys are due. In a separate paper it is hoped to show that the latter are equivalent to the Sierran valleys of the Sierra Nevada province, and that the orographic disturbance referred to in this paragraph was that which terminated the Pliocene and inaugurated typical Quater-

nary conditions in California. It is, therefore, reasonably certain that the upper portion of the Neocene gravels of the Klamath region represents the Upper Pliocene. In short, the alluvial filling of the Neocene valleys is probably the chronologic equivalent of the whole of the Coast Range Pliocene series, with its San Pablo, Berkeleyan, and Merced divisions.

I have correlated in a general way the Neocene baselevel of the Trinity valley with the peneplain of the Sierra Nevada region, but this requires some qualifications. The latter was developed in early Pliocene time and largely buried under andesite lava and tuff during the Middle Pliocene time. Then it was slightly disturbed and partly resurrected by erosion during late Pliocene time. In the Klamath region there were deep cañons in the earlier portion of the Pliocene period, and the Neocene baselevel reached its stage of maximum development at about the close of the period. Then came the great uplift which terminated low-level conditions in both provinces.

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